

thick, though generally thickest in the middle and thinning away to the periphery—sometimes dying away before they reach it, and sometimes extending beyond it. They are generally united to the body of the vertebræ.

Nothing in osteology is more curious than the condition of epiphyses in the long bones of Plesiosaurs; for here they are so enormously large as to form nearly the whole of the bone, the shaft being reduced to a mere girdle encircling the ends of the epiphyses. Young specimens of humerus or femur, with the shaft 2 or 3 inches long, have generally lost their epiphyses; and in one beautiful specimen from the Kimmeridge Clay of Cottenham, presented to the University by the Rev. S. Banks, a shaft nearly *three inches in diameter* has lost both epiphyses. It is quite tubular, smooth in the central part, which is perforated for the enormous arteries, and only shows signs of attachment at its thin ends, where the inner surface is rugged. Often, in the Greensand specimens, the epiphysis of the proximal end comes out. The shaft varies much in proportion, with the species.

X.—On the Systematic Position of the Strepsiptera.

By Professor SCHAUM*.

THE family of the *Strepsiptera* or *Stylopidæ*, so remarkable in their mode of development, was first regarded as a group of Coleoptera by Burmeister (Handb. der Naturgesch., 1837), and placed by him in the immediate vicinity of the Rhipiphoridous genus *Symbius*, Sundev. (Isis, 1831, tab. 8) = *Rhipidius*, Thunb., which is parasitic upon *Blattæ*. This notion has since been adopted by Newman, Schiödte, and other entomologists, and most recently by Lacordaire, who, in the fifth volume of his 'Genera des Coléoptères,' treats the *Stylopidæ* as a family of Beetles standing in immediate contact with the *Rhipiphoridaæ*, and in connexion therewith cites some of the reasons adduced by me in favour of this view, and in opposition to the objections raised against it.

Leconte also, in his recently published work, the 'Classification of the Coleoptera of North America,' has placed the *Stylopidæ* next the *Rhipiphoridaæ*, in consideration of their organization and development. In the "Report on the Progress of Entomology in the year 1861" (Wiegmann's Archiv, xxviii. p. 328), Dr. Gerstäcker makes the following remarks in con-

* Translated by W. S. Dallas, F.L.S., from Wiegmann's 'Archiv,' 1864, p. 145.

nexion with this:—"What characters has a Strepsipteron in common with a Beetle? *Not one.* What are the agreements in their mode of life? The Strepsiptera live parasitically upon Hymenoptera; the larvæ of the Meloidæ feed upon honey: the two *consequently have nothing in common* in their development. In elementary books least of all should absurdities be passed off as good coin." In his Report Dr. Gerstäcker places the Strepsiptera with the Neuroptera with perfect metamorphosis; and in an elementary book, a recently published 'Handbuch der Zoologie' (p. 78), he himself refers them to the Neuroptera as the third tribe.

Without taking any further notice of the tone which the reporter thinks proper to adopt with regard to an opinion entertained by distinguished entomologists (such as Burmeister and Lacordaire), I hope, by a simple enunciation of the facts upon which the decision of the question depends, to enable every zoologist who may take an interest in the matter to form an independent judgment upon the systematic position of the Strepsiptera.

The Strepsiptera undergo a complete metamorphosis; and the males possess buccal organs (mandibles, palpi) which are certainly rudimentary, because the imagines live only for a few hours, but which are to be referred to the mandibulate type. In both these particulars the Strepsiptera agree equally well with the Coleoptera and with the Neuroptera.

In the above-mentioned 'Handbook of Zoology' the characters of the Neuroptera and Coleoptera are stated in the following words:—

Neuroptera (p. 68): "with complete metamorphosis, biting oral organs, free prothorax, and membranous fore and hind wings."

Coleoptera (p. 80): "with complete metamorphosis, biting oral organs, free, strongly developed prothorax, and hard horny fore wings (wing-cases)."

The sole distinction between the two orders is therefore, according to this Handbook, that the Neuroptera have membranous and the Coleoptera hard horny anterior wings; for the "free, strongly developed prothorax" of the Coleoptera cannot be regarded as the opposite of the merely free prothorax of the Neuroptera, among which such genera as *Corydalis* and *Mantispa* possess a much more strongly developed prothorax than many Coleopterous genera.

A further physiological distinction between the two orders, which is indeed connected with the membranous or horny nature of the fore wings, but at the same time presupposes a totally different musculature of the thorax, consists in the fact that the

Neuroptera fly with both pairs of wings, the Coleoptera only with the hinder ones.

The placing of the Strepsiptera with either the Coleoptera or the Neuroptera therefore depends, *in the first place*, upon the questions whether their anterior wings are membranous or horny, and whether both pairs of wings, or only the posterior pair, are used in flight. Of the prothorax, which is very rudimentary in the Strepsiptera, we may for a time take no notice, as, according to the above diagnoses, it is free in both the Neuroptera and Coleoptera.

According to page 78 of the Handbook, the fore wings of the Strepsiptera are "in the form of small stumps, rolled up at the apex." Are these membranous fore wings? Are these organs that take part in flight? Any comparison of these stumps with the membranous *veined* anterior wings of the Neuroptera is quite untenable, because in the orders with two pairs of membranous wings, both assisting in flight (Neuroptera, Hymenoptera, Lepidoptera), the anterior wings are never aborted alone, and, from the preponderant importance of those organs for the purpose of flight, cannot be aborted. In these orders both pairs of wings are sometimes aborted (as in *Boreus* among the Neuroptera), but the function of flight is never transferred entirely to the posterior wings.

But the anterior wings of the Strepsiptera, during the life of these animals, are by no means twisted stumps; and this is expressly insisted on by Smith, who has had the opportunity of observing them alive*: from the delicacy of the insect, they change their form very quickly after death; and their condition in dried specimens consequently enables us to form no opinion of their nature during life. The passage in Smith's paper (Trans. Ent. Soc. ser. 2, vol. iv. p. 116) is as follows:—

"The texture of all parts of the body of a male *Stylops* is of so delicate a nature that within two hours after death the entire appearance of the insect is changed, bearing no more resemblance to the living creature than a shrivelled mummy does to the once graceful Egyptian; the remarkable *lateral appendages of the thorax*" (elsewhere denominated *pseudelytra*), "which in life were *rounded on one side and flattened on the other*, become entirely changed in form."

In Smith's figure, drawn from the life, the anterior wing of *Stylops* shows the most unmistakable analogy with the stunted, widely separated, and gaping elytra of the Coleopterous genera *Symbius* and *Atractocerus* (to which even Westwood called at-

* The extraordinary rarity of the Strepsiptera, and the shortness of their life, which extends only to a few hours, have allowed them to be observed in the living state by only a few entomologists.

tion [Introd. vol. ii. p. 293], although he had only examined dried specimens); it is coriaceous and destitute of veins, like an elytron. Such a structure of the anterior wings stands in the most complete opposition to the most essential character of the Neuroptera.

With this structure of the fore wings, the hinder pair of course constitute the sole organs of flight in the Strepsiptera. In the above-mentioned 'Handbook' (p. 79), the agreement in the radiate venation of the posterior wings is indeed adduced as an argument in favour of the position of the Strepsiptera among the Neuroptera, "only that in the Strepsiptera this occurs still more decidedly and clearly." Neither in their development nor in their venation, however, have the posterior wings any analogue among the Neuroptera; but they find one in the Coleopterous genus *Atractocerus*, as indeed has already been correctly indicated by Westwood in his classical work, the 'Introduction to the modern Classification of Insects' (which is still the only good introduction to the study of special entomology). The radiate arrangement of the venation is indeed characteristic of the posterior wings of the Coleoptera in a far higher degree than of those of the Neuroptera.

Before we pass to the development of the Strepsiptera, we have still to glance at the arguments that have been adduced in favour of their position with the Neuroptera, and the objections which have been raised against their union with the Coleoptera. In the above-mentioned 'Handbook of Zoology' (p. 79) we find "the family (Strepsiptera) by its essential characters" (perhaps the nature of the anterior wings) "naturally approaches the Neuroptera, and among these especially the Phryganidæ. With the latter it agrees in the structure of the prothorax, which never occurs among the Coleoptera, in the elongated, free anterior and middle coxæ, the rudimentary buccal organs, of which the maxillæ are amalgamated with the labium, as also in the radiate venation of the posterior wings, only that the latter is more decidedly and clearly marked; this relationship is further proved by the branchiiform respiratory organs discovered by Newport on the abdominal segments of the larvæ of Strepsiptera."

The Strepsiptera are therefore appended to the Neuroptera, not because they agree with that order in their chief character, the nature of the fore wings (which is rather in complete opposition to the above-cited diagnosis of the Neuroptera), but because they are supposed to agree in some secondary characters with a family (Phryganidæ) which is referred to the Neuroptera. Of these secondary characters, the radiate arrangement of the venation of the posterior wings has already been indicated as characteristic of the Coleoptera. Branchiiform respiratory organs

have been observed on the larvæ of the Strepsiptera neither by Klug nor by Von Siebold (see Wiegmann's 'Archiv,' 1843, p. 154); and even Newport has *not* demonstrated them, but rather expresses himself very cautiously on the subject. He says (Trans. Linn. Soc. xx. p. 345), "In the larvæ there *appeared* to be eight pairs of bag-shaped dark bodies at the sides of the abdominal segments, situated in the place of the respiratory organs of other insects. From their darkened appearance and from their resemblance to branchial sacs, they *may perhaps* be regarded as imperfect respiratory organs of the nature of branchiæ." And such a conjectural statement as this, which is not even remotely put forward as a fact, and appears to apply not to the definitive larva, but to its first stage, is to be taken as "demonstrative" of the affinity of the Strepsiptera to the Neuroptera. No stress can be laid upon the free elongated anterior and middle coxæ in a case in which, as here, we have to deal with the orders of insects. Thus the only remaining arguments for the affinity of the Strepsiptera to the Phryganidæ, and their consequent position among the Neuroptera, are that the buccal organs are rudimentary, and the prothorax is formed as in the Phryganidæ. A rudimentary condition of the buccal organs, with which an amalgamation of the different parts is always associated, does not of itself form any relationship. The buccal organs are aborted in certain genera of all orders of insects, and indeed in such as take no nourishment in the imago state, as in *Ephemera* among the Orthoptera, in the *Henopii* among the Diptera, and in many Bombycidæ among the Lepidoptera. The rudimentary state of the buccal organs is therefore no argument against the position of the Strepsiptera among the Coleoptera; they are Beetles with rudimentary buccal organs, just as the Phryganidæ are Neuroptera with rudimentary buccal organs, if, indeed, from the nature of the anterior wings the Strepsiptera are Beetles, and the Phryganidæ Neuroptera.

"The Strepsiptera agree with the Phryganidæ in the structure of the prothorax, which never occurs in the Coleoptera." According to the diagnoses of the Phryganidæ (p. 75) and the Strepsiptera (p. 78), this structure consists in the prothorax being short and annular. A prothorax is annular when it consists of a single ring, and is not divided into a notum and a sternum. But a prothorax of this kind, forming only a simple ring, occurs among Beetles throughout the division Rhynchoptera. On the other hand, it is by no means settled, and indeed cannot be settled from dried specimens, that the very slightly developed prothorax of the Strepsiptera does not consist of a notum and a sternum. The only thing that remains, therefore, is that the prothorax is short in the Phryganidæ and

Strepsiptera, and free and strongly developed in the Coleoptera. If, then, the Phryganidæ and Strepsiptera, although they possess a short prothorax, are referred to the Neuroptera, among the ordinal characters of which a free prothorax is one (p. 68), this proves, on the one hand, that the above-cited diagnosis does not apply to the numerically larger part of the Neuroptera (the Phryganidæ), and, on the other, that the development of the prothorax does not furnish a character for the order Neuroptera.

Even in the order Hymenoptera the development of the prothorax has not the decided signification which is ordinarily ascribed to it: in most cases indeed it, or at least its notum, is much reduced; but in the family Pompilidæ (for example, in *Salix*) it is well developed. That in the orders of Hemimetabolous Insects (Orthoptera, Hemiptera) the prothorax is sometimes free, sometimes more or less reduced *in correspondence with the structure of the anterior wings*, has already been fully elucidated by Erichson (Germar's 'Zeitschrift,' i. p. 156). The shortness of the prothorax, therefore, proves nothing in favour of the position of the Strepsiptera among the Neuroptera (which, for the most part, possess a free prothorax), and can only be used as an argument against their being placed with the Coleoptera if we refuse to admit that the prothorax may be reduced in this order exceptionally, and indeed in the strictest connexion with the reduction of the anterior wings, just as among the Hymenoptera it is exceptionally strongly developed in *Salix*. In this case we have to regard the Strepsiptera as forming a small independent order, agreeing with the Coleoptera in the perfect metamorphosis, in the possession of (rudimentary) biting oral organs, and in the structure of the wings; and with certain Coleoptera in a very peculiar process of development, but differing in the rudimentary condition of the prothorax*. But in other cases we arrange certain forms in an order, although one or other of the characters of this order do not attain full development in them; for example, we unite the genus *Braula* with the Diptera with reference to certain conditions of organization, and to its development, which takes place as in the section Pupipara of the order Diptera, although it does not possess the essential characters of that order, namely the halteres and the typical structure of the mouth; and if we do so, we may also with perfect justice refer the Strepsiptera to the Coleoptera.

That the mode of life of the Strepsiptera agrees with that of the Meloidæ, so far as the nourishment of the larva is concerned, has never been asserted. It has, however, been affirmed, and correctly, that in this and other respects it agrees with that of

* With regard to the asserted distinction in that the anterior wings are moved when the animals fly, see Lacordaire's 'Gen. Col.' v. 11. p. 693.

the Co.eopterous genus *Rhipidius* (= *Symbius*), which is parasitic in Cockroaches, as the Strepsiptera in Bees and Wasps, and the vermiform female of which does not quit the body of the animal in which it has been developed, any more than the worm-like female of the Strepsiptera. But the Strepsiptera agree with the Meloïdæ (*Meloë* and *Sitaris*, and probably also with *Rhipidius*, the metamorphosis of which is not completely known) in the very remarkable process of development named *hypermetamorphosis* by Fabre, which has hitherto been observed in this form only in the Meloïdæ and Strepsiptera—a process which consists in the production from the egg of a provisory larva, destined to transfer the animal into those conditions under which it is further developed, and in the production from this provisory larva, at the first moult, of a second definitive larva of totally different form.

PROCEEDINGS OF LEARNED SOCIETIES.

ZOOLOGICAL SOCIETY.

April 12, 1864.—E. W. H. Holdsworth, Esq., in the Chair.

NOTES ON THE UROTRICHUS. BY J. K. LORD, F.Z.S.

UROTRICHUS GIBBSII, Baird.

Hab. Western side of Cascade Mountains, Sumass Prairie, near Fraser River.

This singular little animal, which appears to be an intermediate link between the Shrew and the Mole, is at present only known as an inhabitant of two parts of the world, widely removed from each other—the one spot being the western slope of the Cascade Mountains in North-west America, the other Japan. There are, as far as I know, but two specimens extant from the Cascade Mountains,—one in the Smithsonian Museum at Washington; the other, a very fine specimen, that I have recently brought home, and which is now in the British Museum. I have carefully compared the Japanese *Urotrichus* with his brother from the western wilds, and can find no difference whatever, either generically or specifically; in shape, size, and colour they are exactly alike.

The *Urotrichus* is of a bluish black when *fresh*, but in the dried specimens sooty brown. The hair is lustrous and where it reflects the light has a hoary appearance, and, like that of the Mole, can be smoothed in either direction. This is a wise and admirable arrangement, as it enables him to back through his underground roads, as well as to go through them head first. His nose or snout is very curious, and much like that of a pig, only that it is lengthened out into a cylindrical tube covered with short thick hairs, and terminating in a naked fleshy kind of bulb or gland; this gland is pierced by two minute holes, which are the nostrils. Each nostril has a little fold